CLAIMS

What is claimed is:

1. A method for aligning SWNT by subjecting them to a magnetic field.

2. The method of claim 1, wherein said SWNT are selected from the group consisting of derivatized and un-derivatized SWNT.

3. The method of claim 1, wherein said magnetic field is selected from an AC magnetic field and a DC magnetic field.

4. A method for aligning SWNT by subjecting them to an electric field.

5. The method of claim 1, wherein said SWNT are selected from the group consisting of derivatized or un-derivatized SWNT.

6. The method of claim 5, wherein said electric field is selected from an AC electric field and a DC electric field.

7. A method for assembling field-aligned SWNT into a three-dimensional structure in which the tubes are substantially parallel to each other.

8. The method of claim 7, wherein the three-dimensional structure comprises a fiber containing parallel tubes.

9. The method of claim 7, wherein the three-dimensional structure comprises a membrane of substantially parallel SWNT oriented parallel to the plane of the membrane.

10. The method of claim 7, wherein the three-dimensional structure comprises a membrane of substantially parallel SWNT oriented perpendicular to the plane of the membrane.

11. A material of SWNT in which a fraction of a membrane's constituent tubes is in contact with or connected to a substrate at one of their ends.

12. The material of claim 11, wherein said contact is chemical.

13. The material of claim 11, wherein said contact is physical.

14. The material of claim 11, wherein said contact is chemical and physical.

15. The material of claim 11, wherein said structure is suspended in solution.

16. The material of claim 11, wherein said structure is dissolved in solution.

17. A method for removing an assembled three-dimensional structure from a solution.

18. A method for creating objects and materials from field-aligned tubes in solution or suspension, comprising modifying the solvent strength of the nanotube solution to precipitate tubes.

19. A method for creating objects and materials from field-aligned tubes in solution or suspension, comprising forcing diffusion of suspended SWNT in an electric field.

20. A method for condensing field-aligned suspended or solvated SWNT segments are made on a fiber material (carbon fiber or metal wire oriented parallel to the field-alignment direction) that serves as a substrate for initiation of growth of a macroscopic fiber that is predominantly SWNT segments oriented parallel to one another comprising

introducing a fiber substrate,

continuously translating the fiber substrate through the SWNT-containing liquid within a field;

wherein the aligned SWNT condense on the fiber, enabling a continuous production process for a predominantly SWNT fiber.

21. The method of claim 20, further comprising applying an electric field near the substrate; and

growing fiber to facilitate motion of SWNT segments to the fiber.

22. A method for forming a membrane of aligned SWNT comprising:

field-aligning end-derivatized SWNT; and

diffusing and chemically attaching the SWNT to a substrate that is oriented perpendicular to the field-alignment direction;

wherein the membrane comprises a plurality of contiguous, parallel SWNT segments aligned in a direction that is substantially perpendicular to the substrate surface.

23. A material that employs membranes or arrays of substantially-aligned SWNT as field emitters of electrons.

24. A material comprising an array of substantially-aligned SWNT to function as a field-emitter of electrons.

25. A material that serves as the active element (tip) of a probe microscope that is assembled by a technique that involves field-alignment of SWNT.

26. A method for forming a nanotube membrane of substantially aligned single wall nanotubes (SWNT) comprising:

suspending SWNT segments in a surfactant solution;

pumping said solution through a filter assembly;

applying a magnetic field near said filter assembly;

flushing said filter assembly;

drying said filter assembly; and

separating a membrane of substantially aligned SWNT from a surface of said filter assembly.

27. The method of claim 26, wherein said magnetic field is produced by a magnetic field source selected from the group consisting of permanent magnets and electromagnets.

28. The method of claim 26, wherein said membrane is 10 microns thick.

29. The method of claim 26, wherein said membrane is macroscopic.

30. A material comprising:

a plurality of substantially aligned single wall nanotubes.

31. The material of claim 30 wherein the nanotubes are aligned in a matrix of another material.

32. The material of claim 32 wherein the nanotubes are locally aligned in ropes that form a network within the matrix

33. The material of claim (30) wherein the aligned nanotubes are held apart by chemical moieties attached to the nanotubes.

34. The material of claim (30) wherein the material is intercalated with a metal species inside or between the individual nanotubes.

35. The material of claim 30 wherein a plurality of the aligned single wall nanotubes are in van der Waals contact with their nearest neighbors.

36. The material of claim 30, wherein said material is macroscopic.

37. The material of claim 30, wherein said material is at least 10 microns thick.

38. The material of claim 30, where said material has a use selected from the group consisting of high strength fiber and cable, electrical transmission lines, structural materials, impact-resistant materials, armor, structural laminates having layers with different tube orientations, pressure vessel exteriors and reinforcement, thermal management materials (e.g., heat-transporting materials), heat-resistant materials, airframes and airframe components for aircraft and missiles, vehicle bodies, ship hulls, chemically inert materials, electrochemical electrodes, battery electrodes, catalyst supports, biologically-inert materials, sensors, materials that absorb, support and dispense moieties that intercalate, and transducer elements.

39. The material of claim 30, wherein said material is used as a substrate for initiation of growth of nanotube assemblies.

40. An apparatus for forming arrays of substantially aligned SWNT, comprising:

a source of suspended SWNT;

an area for receiving said suspended SWNT;

a source of a magnetic field for application to said area; and

a filter for receiving said SWNT.

41. The apparatus of claim 40, wherein said source of a magnetic field is selected from a group consisting of permanent magnets, electromagnets, and superconducting electromagnets.

42. The apparatus of claim 40, wherein said magnetic field has a strength of at least 0.5 T.

43. The apparatus of claim 40, wherein said SWNT are suspended in DMF.

44. The apparatus of claim 40, wherein said suspended SWNT are forced through said area by high-pressure gas.

45. The apparatus of claim 40, wherein said suspended SWNT are pulled through said area by a vacuum.

46. An apparatus for forming arrays of substantially aligned SWNT, comprising:

a tank;

a positive electrode disposed in said tank;

a negative electrode disposed in said tank;

a filter disposed in said tank near said positive electrode;

a plurality of SWNT suspended in a solution in said tank such that said filter is between said SWNT and said positive electrode;

a source of a magnetic field for aligning said SWNT;

wherein said SWNT migrate toward said positive electrode in response to the application of a voltage differential and are caught on said filter.

47. A method for forming arrays of substantially aligned SWNT comprising:

suspending a plurality of SWNT in a tank; and

applying a magnetic field to said SWNT;

wherein said SWNT substantially align in response to said application of said magnetic field.

48. The method of claim 47, wherein said substantially aligned SWNT interact to form bundles of SWNT.

49. The method of claim 48, wherein said bundles of substantially aligned SWNT migrate to a bottom of said tank.

50. The method of claim 47, further comprising applying an electric field to said tank, wherein said electric field causes said substantially aligned SWNT to separate from solution.

51. The method of claim 47, further comprising introducing an ionic salt such that said ionic salt causes said substantially aligned SWNT to separate from solution.

52. A method of controlling the proclivity of nanotube segments in a specified environment to self assemble into small ordered structures by modifying the environment of the nanotubes to enhance self assembly to form larger macroscopic ordered nanotube assemblies.

53. The method of claim 52 where the modified environment is selected from a pre-assembly environment and an assembly environment.

54. The method of claim 53 wherein SWNT ropes in solution are treated with graphite intercalating acid.

55. The method of claim 52 further comprising alignment of SWNT by subjecting a viscous fluid containing SWNT to shear forces by extruding and/or drawing an SWNT paste through an orifice.

56. The method of claim 53 wherein SWNT and ropes are treated with fuming sulfuric acid.

57. A method of post-processing macroscopic ordered nanotube assemblies to selectively enhance material properties.

58. The method of claim 57 wherein the post-processing comprises inducing cross-linking between the sides of tubes as they lie parallel to one another.

59. The method of claim 58 wherein the step of inducing cross-linking comprises introducing a chemical agent .

60. The method of claim 58 wherein the agent intercalates the ordered material and bonds chemically to the adjacent tubes.

61. The method of claim 58 wherein the step of inducing cross-linking comprises applying ionizing radiation to cause dislocations in the tube sidewalls and heat to create rearrangements and bonding between the walls of adjacent sidewalls.

62. The method of claim 53 wherein the post-processing comprises applying heat annealing of the ordered material to join abutting ends of essentially-collinearly-arranged nanotube segments.

63. A material comprising a macroscopic ordered assembly of SWNT wherein ends of essentially-colinearly-arranged and abutting segments are joined to combine segments into a single tube within the ordered assembly.